

BLM LIBRARY



88075041

UNIVERSITY OF WYOMING COOPERATIVE RESEARCH REPORT
TO THE BUREAU OF LAND MANAGEMENT

1980

SOIL-VEGETATION RELATIONSHIPS ON RANGELAND ENCLOSURES IN THE OVERLAND
PLANNING UNIT OF SOUTH CENTRAL WYOMING

S
131
.E6
S3
no. 1042

BUREAU OF LAND MANAGEMENT
Library
Denver Service Center

82

ELM Library
D-553A, Building 50
Denver Federal Center
P. O. Box 25047
Denver, CO 80225-0047

i

S
131
EG
53
No. 1042

SOIL-VEGETATION RELATIONSHIPS ON RANGELAND ENCLOSURES
IN THE OVERLAND PLANNING UNIT OF SOUTH CENTRAL WYOMING¹

BY

H. G. Fisser, D. C. Trueblood, and C. H. Butterfield²

1980

Table of Contents

Introduction.	1
Description of the Study Area	3
Methods	5
Soils.	5
Vegetation	6
Results	7
Soils.	7
Vegetation	11
Soil-vegetation Relationships.	15
Summary	23
Literature Cited.	25
Appendix A.	28
Appendix B.	44
Appendix C.	61

¹Published with the approval of the Director, Wyoming Agricultural Experiment Station, as Scientific Report No. 1042

²Professor of Range Management, Graduate Research Assistant, and Graduate Student, Division of Range Management, University of Wyoming, Laramie, respectively.

Electricity
D-633A, Building 50
Denver Federal Center
P. O. Box 25047
Denver, CO 80225-0047

List of Tables

	Page
Table 1. Name, legal description, and county location of the 11 exclosures studied in the Overland Planning Unit.	3
Table 2. List of code acronyms and corresponding genus and species with which specific study sites were identified at multiple type exclosures.	8
Table 3. Taxonomic soil orders, sub-orders, and great groups at the 16 study sites of the 11 exclosure locations in the Overland Planning Unit.	8
Table 4. Distribution of the study sites among the two soil orders and four sub-orders present.	8
Table 5. Ranges of soil chemical properties studied.	10
Table 6. Dominant overstory and understory species at the 16 study sites of the 11 exclosure locations in the Overland Planning Unit.	12
Table 7. Vegetation types of the 16 study sites at the 11 exclosure locations in the Overland Planning Unit.	12
Table 8. Ranges and means for total and understory vegetative cover for the six vegetation types at the 11 exclosures studied.	13
Table 9. Distribution of the vegetation types among the soil orders and sub-orders occurring at the 11 exclosure locations.	16
Table 10. Ranges and means for total percent cover for each soil order and sub-order occurring at the 11 exclosure locations.	16
Table 11. Comparison of the ranges and means of the effective rooting depth among the vegetation types.	16

	Page
Table 12. Comparison of the effective rooting depth with total percent vegetative cover within the juniper vegetation type.	18
Table 13. Comparison of the percentage of sand with total percent vegetative cover within the juniper vegetation type.	18
Table 14. Comparison of the percentage of very fine sand with total percent vegetative cover within the juniper vegetation type.	18
Table 15. Comparison of the percentage of silt with total percent vegetative cover within the juniper vegetation type.	19
Table 16. Comparison of the ranges and means of the percentage of silt among the vegetation types.	19
Table 17. Comparison of the ranges and means of the pH of a 1:5 dilution among the vegetation types.	19
Table 18. Comparison of the pH of a saturated soil paste with total percent vegetative cover within the juniper vegetation type.	20
Table 19. Comparison of the percentage of calcium carbonate with total percent vegetative cover within the juniper vegetation type.	20
Table 20. Comparison of the ranges and means of percent soil moisture in the profile at 15 bars among the vegetation types.	20

List of Figures

Figure 1. Map of the study area showing locations of the exclosures studied.	4
--	---

List of Appendices

Appendix A. Soil profile descriptions	28
Appendix B. Soil chemical analyses	44
Appendix C. Percent vegetative cover	61

INTRODUCTION

The University of Wyoming and Bureau of Land Management entered into an agreement in 1979 to comprehensively describe some soil-vegetation relations of three planning unit areas in Western Wyoming: Grass Creek in the Big Horn Basin, Salt Wells in southwestern Wyoming, and the Overland unit of southcentral Wyoming, the subject of this report. Rangeland exclosures were constructed within these areas in years past. Vegetation and site data have been obtained and recorded from these exclosures. Vegetation data included herbage production, cover, and composition values from as early as 1960; some obtained annually and some less often. Information such as moisture, temperature, and soil description were recorded at some exclosure sites for definitive expression of environmental conditions.

The geographic distribution of the exclosures provides great vegetational and edaphic diversity and obvious heterogeneity of environmental characteristics. The objectives of this program were (1) to inventory and characterize soils within rangeland exclosures and (2) to interrelate the soil characteristics with long term vegetation data.

The soil inventory and soil-vegetation relationship information from these exclosures can provide a valuable data base for use by the Bureau of Land Management to increase effectiveness of decision

processes as applied to rangeland resource management and use. In addition, these data will contribute to the better understanding of rangeland and synecology and soil taxonomy on these sites; and, as well, will enhance information transfer to those concerned with use and management of natural resources.

This is the third publication of data related to the University and BLM program. The first gave information of exclosures in the Grass Creek Planning Unit of the Big Horn Basin (Fisser, et. al. 1979). The second publication recently completed, described soils and vegetation of exclosures in the Salt Wells Planning Unit of southwest and western Wyoming (Fisser and Trueblood, 1980). This publication, to be cited as Fisser and Trueblood, 1980, presents data from exclosures in the south-central Wyoming Overland Planning Unit area.

The format of the three publications has been kept uniform. Formal statistical analyses have not been applied to the interpretive processes of defining soil-vegetation relations; rather the authors have inspected the sites and their characteristics and derived then, from the complex of data sets, the most logical explanation for apparent existence of relationships as trends. These interpretations, based on general known characteristics of plant response to soil-environmental criteria are difficult to define, and to justify in some cases because of limited data, but can be expected to be substantiated when more data become available.

In the near future are expected to be completed two M.S. theses dealing primarily with sophisticated statistical analyses of data from the Grass Creek Planning Unit data set. In addition a final comprehensive document of all three planning unit data sets with statistical data processing will be prepared.

DESCRIPTION OF THE STUDY AREA

This study was done on 11 exclosures in the Overland Planning Unit which is located in the Red Desert of southcentral Wyoming (Table 1, Figure 1). This is an area of little precipitation, high summer temperatures and high evaporation with soils that tend to be alkaline and calcareous. Much of the area is dominated by shrubs, principally big sagebrush (Artemisia tridentata). For a detailed description of the environment at each exclosure, see the soil profile descriptions (Appendix A).

Table 1. Name, legal description, and county location of the 11 exclosures studied in the Overland Planning Unit.

Exclosure	Location	County
Oppenheimer	SW $\frac{1}{4}$, Sec. 5, T13N, R92W	Carbon
Poison Buttes #1	SE $\frac{1}{4}$, Sec. 25, T13N, R92W	Carbon
Poison Buttes #2	SE $\frac{1}{4}$, Sec. 36, T13N, R92W	Carbon
Powder Rim A	SW $\frac{1}{4}$, Sec. 25, T13N, R95W	Sweetwater
Powder Rim B #1	SW $\frac{1}{4}$, Sec. 36, T13N, R95W	Sweetwater
Powder Rim B #2	NW $\frac{1}{4}$, Sec. 10, T12N, R95W	Sweetwater
Powder Rim C	SW $\frac{1}{4}$, Sec. 28, T13N, R93W	Carbon
Powder Rim D	SW $\frac{1}{4}$, Sec. 26, T13N, R94W	Sweetwater
Red Wash #1	SW $\frac{1}{4}$, SE $\frac{1}{4}$, Sec. 22, T16N, R93W	Carbon
Red Wash #2	SE $\frac{1}{4}$, SW $\frac{1}{4}$, Sec. 2, T17N, R95W	Sweetwater
Red Wash #3	NW $\frac{1}{4}$, NE $\frac{1}{4}$, Sec. 6, T17N, R92W	Carbon

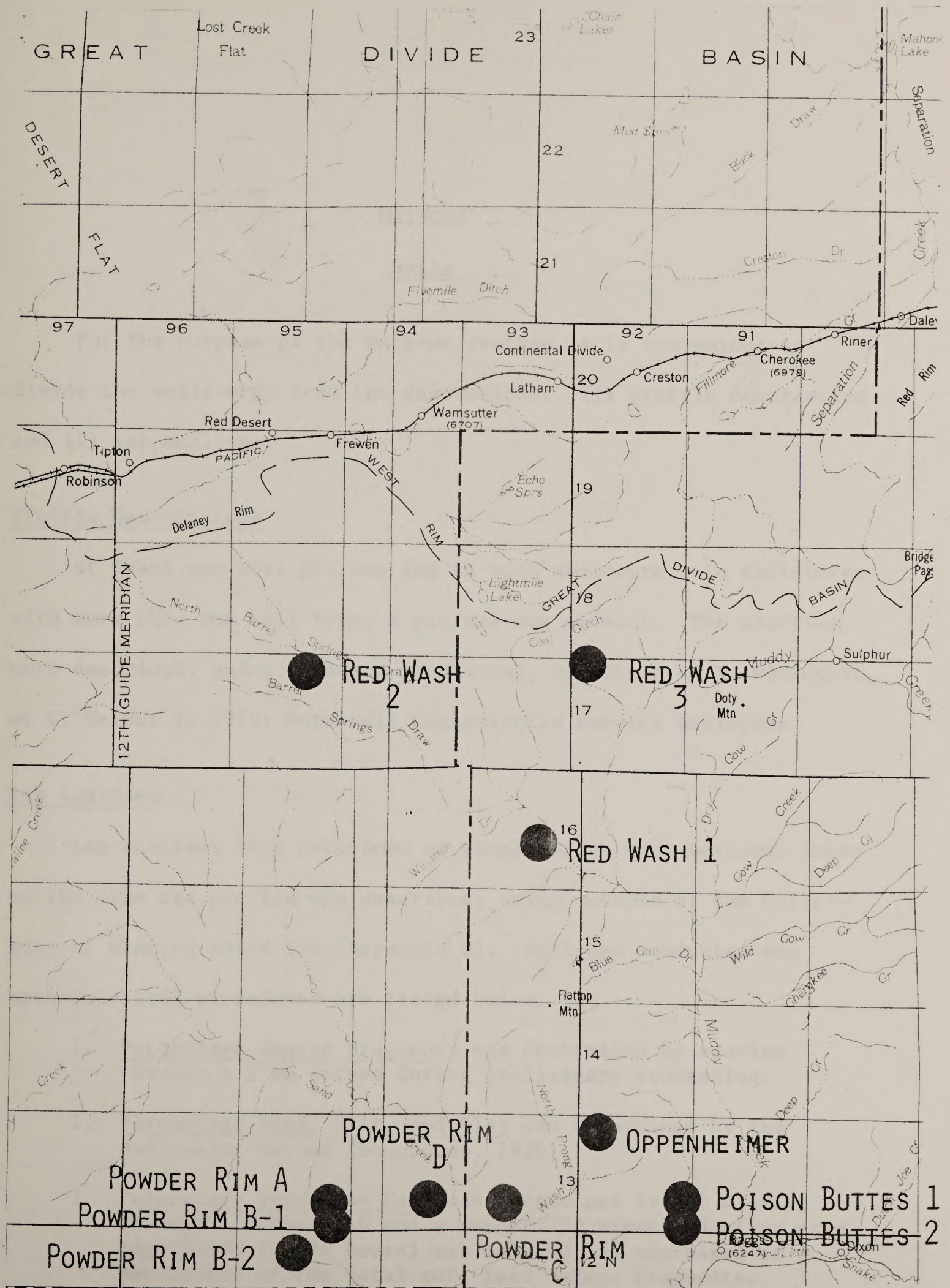


Figure 1. Map of the study area showing locations of the exclosures studied. (Adapted from U.S. Geological Survey Wyoming Base Map)

METHODS

Soils

For the purpose of the methods section it is convenient to divide the soils work into two discussions: (1) profile description and (2) lab analyses.

Profile Descriptions

At least one soil pit was dug in each enclosure. In enclosures with more than one soil type, a pit was dug in each. The profiles were described, using standard procedures, by either H. B. Ravenholt, or L. Malnor in 1979; both Soil Conservation Service employees.

Lab Analyses

Lab analyses were performed on samples from each horizon, taken at the time the profile was described, using methods of the University of Wyoming soils lab (Appendix B). Analyses conducted and methodological procedures are listed below.

1. Percentage Coarse Fragments was determined by sieving through a 2 mm screen during preliminary processing.
2. Percentage Sand, Silt, and Clay was determined by the hydrometer method (Bouyoucos, 1936).
3. Percentage Very Fine Sand was determined by wet sieving through a number 140 and a number 270 sieve and after drying (110°C for 24 hours) was weighed and expressed as a percentage of the total soil less coarse fragments.
4. Bulk Density was determined using clods from each horizon collected in the field and coated with saran dissolved in methyl ethyl ketone (Soil Conservation Service, 1972,

modified). These clods were dried and weighed and the volume measured by displacement of water.

5. pH was determined using a glass electrode pH meter both on a saturated soil paste and on a 1:5 dilution.
6. Electrical Conductivity (EC) was determined on an extract of a soil paste using a conductivity bridge (U.S. Salinity Laboratory, 1954).
7. Percentage Organic Matter was determined by the 1934 Walkley and Black method (Black 1965).
8. Calcium Carbonate Equivalent was determined by the rapid titration method (U.S. Salinity Laboratory, 1954).
9. Percentage Soil Moisture Holding Capacity was determined in the laboratory at 1/3 and 15 bars on soil passed through a 2 mm sieve (fines) and on the saran coated clods (profile) using a pressure plate apparatus (Soil Conservation Service, 1972, modified).
10. Potential Available Moisture was determined in the laboratory, both for the profile (saran coated clods) and for the fines (<2 mm), as the difference between the percentage soil moisture at 1/3 and at 15 bars.
11. Effective Rooting Depth was determined as the depth to an in-penetrable layer (J. R. Stephens 1979 personal communications). Actual rooting depth may be obtained from the profile descriptions.

Vegetation

All vegetation data was taken from the annual progress reports of an on-going cooperative research project with the Bureau of Land Management (Fisser, et. al. 1962-1978) and from research files at the University of Wyoming. For detailed discussion of the methods used refer to these reports. The vegetation data is presented as long term means for cover for shrubs, perennial grasses, annual grasses, perennial forbs, annual forbs, and total (Appendix C).

RESULTS

The soils and vegetation are addressed separately and then combined for discussion of soil-vegetation relationships. Interpretive evaluation has been derived through observation of site and data conditions and trends (vegetative and edaphic).

Soils

For the 11 exclosures there are 15 profile descriptions. The profile description for one site (Poison Buttes Exclosure #2-Game Exclosure) was not available. There are, then 16 "study sites". For those exclosures in which there is only one soil type, the study site and profile descriptions are identified by the exclosure name. For those exclosures including more than one soil type, the study sites and profile descriptions are differentiated by the exclosure name plus some identifying characteristic. This differentiating characteristic may be a description of the type of exclosure (Game exclosure or Livestock exclosure) or of the dominant vegetation. When a description of the vegetation is used a code for a dominant and differentiating species follows the exclosure name. These species codes are formed by combining the first two letters of the genus name with the first two letters of the species name (Table 2). Whatever method is used for differentiation, all study sites within an exclosure are identified by the same method, and the study site is identified by the same name throughout this report.

Table 2. List of code acronyms and corresponding genus and species with which specific study sites were identified at multiple type exclosures.

Species Code	Name
ARPE	Artemisia pedatifida
ARTR	Artemisia tridentata
ATGA	Atriplex gardneri
GRSP	Grayia spinosa

Table 3. Taxonomic soil orders, sub-orders, and great groups at the 16 study sites of the 11 exclosure locations in the Overland Planning Unit.

Study Site	Order	Sub-order	Great Group
Oppenheimer	Aridisol	Argid	Haplargid
Poison Buttes #1	Aridisol	Argid	Haplargid
Poison Buttes #2 (Game)	*	*	*
Poison Buttes #2 (Livestock)	Entisol	Fluvent	Torrifluvent
Powder Rim A	Aridisol	Orthid	Calciorthid
Powder Rim B #1 (ARTR)	Aridisol	Argid	Haplargid
Powder Rim B #1 (ATGA)	Aridisol	Argid	Natrargid
Powder Rim B #2	Aridisol	Orthid	Calciorthid
Powder Rim C	Aridisol	Orthid	Calciorthid
Powder Rim D	Aridisol	Argid	Natrargid
Red Wash #1 (ATGA)	Aridisol	Argid	Natrargid
Red Wash #1 (GRSP)	Entisol	Psamment	Torripsamment
Red Wash #2 (Grass)	Aridisol	Orthid	Camborthid
Red Wash #2 (GRSP)	Entisol	Psamment	Torripsamment
Red Wash #3 (ARPE)	Aridisol	Argid	Natrargid
Red Wash #3 (ARTR)	Aridisol	Orthid	Camborthid

*--No data available

Table 4. Distribution of the study sites among the two soil orders and four sub-orders present.

Order	Sub-order	Number of Study Sites
Aridisol		12
	Argid	7
	Orthid	5
Entisol		3
	Fluvent	1
	Psamment	2

The soil at each site was classified according to the new comprehensive classification system (Table 3). The distribution of the soils is as might be expected when related to the semi-arid temperate climate of the area (Table 4). All of the soils are in the orders Aridisol and Entisol. A dry climate determines the order Aridisol and may also severely restrict soil development thus producing Entisols (Soil Survey Staff 1975).

Most of the sub-orders and great groups present are characterized by the dry conditions, coarse soil texture, high sodium content, and/or high calcium content. The sub-order not distinguished by these characteristics (Fluvent) is characterized by the influence of alluvial deposition upon soil development.

Comparisons of soil chemical properties will be made throughout this report using a single numerical value for each property at each study site. Each value represents the mean for all horizons within the rooting depth at a specific study site. The chemical properties of the soils vary widely (Table 5).

Of the 14 soil series found within the 11 exclosures, only one occurs at more than one study site. This diversity of soil series represents important physical and chemical variation that will be evaluated in greater detail in subsequent portions of this report. The only soil series found at multiple sites is the Kandaly series which is found at two sites, Red Wash #1-GRSP and Red Wash #2-GRSP. Some of the soil chemical properties at these sites are similar, but many are dissimilar.

Table 5. Ranges of soil chemical properties studied.¹

Chemical Property	High	Low
Percent Coarse (<2mm)	41	0
" Sand	89	31
" Silt	39	6
" Clay	44	5
" Very Fine Sand	62	8
Bulk Density	1.85	1.23
pH paste	9.0	7.7
P 1:1	9.8	8.3
Electrical Conductivity (mmho)	2.3	.2
Percent Organic Matter	10.0	.7
Percent Calcium Carbonate	16.0	3.0
Percent Soil Moisture Holding Capacity		
Profile 1/3 bar	25.51	5.37
15 bar	15.44	2.50
Available	12.52	1.67
Fines 1/3 bar	31.91	6.45
15 bar	19.03	4.27
Available	16.95	2.18

¹ Each value represents the mean of all horizons within the rooting depth at a specific study site.

Vegetation

Of the 16 study sites, two (Red Wash #1-GRSP and Red Wash #2-GRSP) have no specific vegetation data. There are, however, general vegetation descriptions, obtained by observation at the sites, which give the dominant species (Table 6). All of the other 14 study sites have data for vegetative cover (Appendix C). The two vegetative parameters studied, vegetation type and percent cover, will be discussed separately.

Vegetation Type

The 16 study sites have been identified into six vegetation types (Table 7). The sagebrush type is the most common (7 sites), occurring at 44 percent of the sites. This seems to follow the general distribution of vegetation in the study area. It is also interesting that none of the sites in the juniper type have a significant understory.

Vegetation Cover

The grass and juniper types appear to have a higher total cover than other types (Table 8). The saltbush type has the lowest total cover and the sagebrush and birdsfoot sagewort types have intermediate total cover values. All values are, however, within the range of values for the sagebrush type.

For understory cover, the value for the grass type is much higher than those for the other types. This is to be expected because in a grass type the total cover is mostly understory. The distribution

Table 6. Dominant overstory and understory species at the 16 study sites of the 11 enclosure locations in the Overland Planning Unit.

Study Site	Dominant Overstory Species	Dominant Understory Species
Oppenheimer	<i>Artemisia tridentata</i>	<i>Stipa comata</i>
Poison Buttes #1	<i>Artemisia tridentata</i>	<i>Agropyron smithii</i>
Poison Buttes #2 (Game)	<i>Juniperus osteosperma</i>	**
Poison Buttes #2 (Livestock)	<i>Juniperus osteosperma</i>	**
Powder Rim A	<i>Artemisia tridentata</i>	<i>Agropyron smithii</i>
Powder Rim B #1 (ARTR)	<i>Artemisia tridentata</i>	<i>Agropyron smithii</i>
Powder Rim B #1 (ATGA)	<i>Atriplex gardneri</i>	<i>Agropyron smithii</i>
Powder Rim B #2	<i>Juniperus osteosperma</i>	**
Powder Rim C	<i>Artemisia tridentata</i>	<i>Stipa comata</i>
Powder Rim D	<i>Artemisia tridentata</i>	<i>Stipa comata</i>
Red Wash #1 (ATGA)	<i>Atriplex gardneri</i>	**
Red Wash #1 (GRSP)	<i>Grayia spinosa</i>	*
Red Wash #2 (Grass)	<i>Artemisia pedatifida</i>	<i>Oryzopsis hymenoides/</i> <i>Agropyron spicatum/</i> <i>Stipa comata</i>
Red Wash #2 (GRSP)	<i>Grayia spinosa</i>	*
Red Wash #3 (ARPE)	<i>Artemisia pedatifida</i>	<i>Agropyron smithii</i>
Red Wash #3 (ARTR)	<i>Artemisia tridentata</i>	<i>Poa sandbergii</i>

*--No data available

**--No significant understory

Table 7. Vegetation types of the 16 study sites at the 11 enclosure locations in the Overland Planning Unit.

Study Site	Vegetation Type
Oppenheimer	Sagebrush
Poison Buttes #1	Sagebrush
Poison Buttes #2 (Game)	Juniper
Poison Buttes #2 (Livestock)	Juniper
Powder Rim A	Sagebrush
Powder Rim B #1 (ARTR)	Sagebrush
Powder Rim B #1 (ATGA)	Saltbush
Powder Rim B #2	Juniper
Powder Rim C	Sagebrush
Powder Rim D	Sagebrush
Red Wash #1 (ATGA)	Saltbush
Red Wash #1 (GRSP)	Hopsage
Red Wash #2 (Grass)	Grass
Red Wash #2 (GRSP)	Hopsage
Red Wash #3 (ARPE)	Birdsfoot sagewort
Red Wash #3 (ARTR)	Sagebrush

Table 8. Ranges¹ and means for total and understory vegetative cover for the six vegetation types at the 11 exclosures studied.

Vegetation Type	Percent Cover					
	Total			Understory		
	High	Low	Mean	High	Low	Mean
Sagebrush	65.5	6.0	18.8	19.7	1.4	5.7
Juniper	24.4	21.7	22.9	2.5	1.5	2.0
Hopsage			*			*
Saltbush	16.6	10.0	13.3	1.7	1.2	1.5
Birdsfoot sage- wort			18.5			9.7
Grass			26.6			19.8

¹Open data entries represent types with only one site
 *--No data available

for other types is similar to that for total cover except that the juniper type has a low understory cover but a high total cover. The range of values for the sagebrush type includes the mean values for all other types except the grass type which is higher.

Kandaly Soil Series at Multiple Sites

The two study sites at which the Kandaly soil series occurs (Red Wash #1-GRSP and Red Wash #2-GRSP) have no vegetation data available.

Soil-Vegetation Relationships

The soil-vegetation relationships section is separated into sub-sections, each of which discuss the relationship of the vegetation parameters, vegetation type and percent cover with a single soil property. Vegetation production and cover comparisons are discussed only within the sagebrush and juniper types because they are the only types occurring at more than two study sites. Soil-vegetation relationships are not considered for the Kandaly soil series as it appears at multiple sites because vegetation data for those sites is not available. In addition, the relationships within the juniper type should be carefully considered because information from only three sites is used.

Soil Type

Two vegetation types each occur on soils classified in one sub-order (Table 9): the hopsage type on psamments and the salt-bush type on argids. The sagebrush vegetation type occurs only on soils classified in the order Aridisol but is evenly distributed between the two sub-orders. The juniper type, however, occurs on soils classified in both orders. In addition, there does not appear to be any relationship between soil type and percent cover (Table 10).

Rooting Depth

The effective rooting depth appears to be related to vegetation type (Table 11). There appears to be a gradient from the Birdsfoot sagewort type which has the shallowest effective

Table 9. Distribution of the vegetation types among the soil orders and sub-orders occurring at the 11 enclosure locations.

Order	Sub-order	Vegetation Types					
		Sagebrush	Juniper	Hopsage	Saltbush	Birdsfoot Sagewort	Grass
Aridisol		7	1		2	1	1
	Argid	4			2	1	
	Orthid	3	1				1
Entisol			1	2			
	Fluvent		1				
	Psamment			2			

Table 10. Ranges¹ and means for total percent cover for each soil order and sub-order occurring at the 11 enclosure locations.

Order	Sub-order	Total Percent Cover		
		High	Low	Mean
Aridisol		65.5	6.0	18.8
	Argid	18.7	6.0	13.1
	Orthid	65.5	6.1	26.7
Entisol				24.4
	Fluvent			24.4
	Psamment			*

1--Open data entries represent types with only one site.

*--No data available.

Table 11. Comparison of the ranges¹ and means of the effective rooting depth among the vegetation types.

Vegetation Type	Effective Rooting Depth (inches)		
	High	Low	Mean
Juniper	60	5	34
Sagebrush	70	8	43
Hopsage	60	42	51
Saltbush	60	60	60
Birdsfoot Sagewort			2
Grass			17

1--Open data entries represent types with only one site.

rooting depth to the saltbush type which has the deepest effective rooting depth. There also appears to be a direct relationship between the effective rooting depth and total percent cover within the juniper vegetation type (Table 12).

Coarse Fragments

There does not seem to be any relationship between the percentage of coarse fragments and vegetation type or percent cover for the sites studied.

Texture

There appears to be a direct relationship between the percentage of sand and total percent cover within the juniper type (Table 13). The percentage of very fine sand also seems to be related to total percent cover within the juniper type, but inversely (Table 14). The percentage of silt also appears to be inversely related to total percent cover within the juniper type (Table 15) and, in addition, to vegetation type (Table 16).

pH

There seems to be a relationship between vegetation type and the pH of a 1:5 dilution (Table 17). In addition, the pH of a saturated soil paste appears to be inversely related to total percent cover within the juniper type (Table 18).

Organic Matter

There does not appear to be any relationship between the organic matter content of the soil and either vegetation type or percent cover for the sites studied.

Table 12. Comparison of the effective rooting depth with total percent vegetative cover within the juniper vegetation type.

Study Site	Effective Rooting Depth (inches)	Total Vegetative Cover (%)
Poison Buttes #2 - Livestock	60	24.4
Poison Buttes #2 - Game	36	22.6
Powder Rim B #2	5	21.7

Table 13. Comparison of the percentage of sand with total percent vegetative cover within the juniper vegetation type.

Study Site	Sand (%)	Total Vegetative Cover (%)
Poison Buttes #2 - Livestock	77	24.4
Poison Buttes #2 - Game	73	22.6
Power Rim B #2	57	21.7

Table 14. Comparison of the percentage of very fine sand with total percent vegetative cover within the juniper vegetation type.

Study Site	Very Fine Sand (%)	Total Vegetative Cover (%)
Powder Rim B #2	22.4	21.7
Poison Buttes #2 - Game	19.5	22.6
Poison Buttes #2 - Livestock	12.5	24.4

Table 15. Comparison of the percentage of silt with total percent vegetative cover within the juniper vegetation type.

Study Site	Silt (%)	Total Vegetative Cover (%)
Powder Rim B #2	35	21.7
Poison Buttes #2 - Game	16	22.6
Poison Buttes #2 - Livestock	12	24.4

Table 16. Comparison of the ranges¹ and means of the percentage of silt among the vegetation types.

Vegetation Type	Silt (%)		
	High	Low	Mean
Hopsage	9	6	8
Juniper	35	11	21
Sagebrush	39	13	21
Saltbush	35	25	30
Grass			16
Birdsfoot sagewort			17

1--Open data entries represent types with only one site.

Table 17. Comparison of the ranges¹ and means of the pH of a 1:5 dilution among the vegetation types.

Vegetation Type	pH		
	High	Low	Mean
Juniper	8.9	8.3	8.6
Sagebrush	9.6	8.5	8.8
Saltbush	9.4	8.9	9.2
Hopsage	9.8	8.9	9.4
Grass			8.8
Birdsfoot sagewort			9.2

1--Open data entries represent types with only one site.

Table 18. Comparison of the pH of a saturated soil paste with total percent vegetative cover within the juniper vegetation type.

Study Site	pH	Total Vegetative Cover (%)
Powder Rim B #2	7.9	21.7
Poison Buttes #2 - Game	7.8	22.6
Poison Buttes #2 - Livestock	7.7	24.4

Table 19. Comparison of the percentage of calcium carbonate with total percent vegetative cover within the juniper vegetation type.

Study Site	CaCO ₃ (%)	Vegetative Cover (%)
Powder Rim B #2	16.0	21.7
Poison Buttes #2 - Game	7.3	22.6
Poison Buttes #2 - Livestock	4.0	24.4

Table 20. Comparison of the ranges¹ and means of percent soil moisture in the profile at 15 bars among the vegetation types.

Vegetation Type	Soil Moisture at 15 bars (%)		
	High	Low	Mean
Saltbush	13.00	11.88	12.44
Juniper	15.44	3.89	8.67
Sagebrush	13.17	4.02	7.91
Hopsage	5.69	2.50	4.10
Grass			3.94
Birdsfoot sagewort			3.78

1--Open data entries represent types with only one site.

Calcium Carbonate

The percentage of calcium carbonate appears to be inversely related to total percent cover in the juniper type (Table 19). There does not appear to be any relationship between the percentage of calcium carbonate and vegetation type for the sites studied.

Electrical Conductivity

There does not seem to be any relationship between the electrical conductivity of a soil paste extract and either vegetation type or percent cover for the sites studied.

Bulk Density

There does not seem to be any relationship between bulk density and either vegetation type or percent cover for the sites studied.

Soil Moisture Relationships in Profile (Saran coated clods)

The percent soil moisture in the profile at 15 bars appears to be related to vegetation type (Table 20). Specifically, there appears to be three groups of vegetation types. One group has relatively low soil moisture percentages at 15 bars (hopsage, grass, and Birdsfoot sagewort types), one has relatively moderate moisture percentages (sagebrush and juniper types), and one has relatively high moisture percentages (saltbush type). It must be remembered, however, that in the field these soils may not necessarily reach the moisture contents at even the 15 bar level. The percent soil moisture in the profile at 1/3 bar and the potential available moisture in the profile do not appear to be related to either vegetation type or percent cover, and the

percent soil moisture in the profile at 15 bars does not appear to be related to percent cover for the sites studied.

Soil Moisture Relationships in Fines

Neither the percent moisture in the fines at 1/3 bar or 15 bars, nor the potential available moisture in the fines appear to have any relationship with either vegetation type or percent cover for the sites studied.

SUMMARY

Eleven exclosure locations in the Overland Planning Unit of south central Wyoming were studied to evaluate relationships between soils and vegetation under rangeland conditions. Specific objectives were:

- 1) To inventory and characterize soils within rangeland exclosures.
- 2) To interrelate the soil characteristics with long term vegetation data.

The soils in this area show a low degree of development, probably due to the arid conditions. Because of this, the soils at all locations studied are classified into the orders Aridisol (characterized by a dry climate) or Entisol (characterized by a lack of development). Of the 16 study sites, however, the soils at only two were classified in the same soil series which provides great variation in both chemical and physical parameters.

At 44 percent of the study sites, the vegetation is dominated by sagebrush. At the remainder of the study sites the vegetation is dominated by other species of drought tolerant shrubs with the exception of one site at which the vegetation is dominated by perennial grasses.

The following are the relationships between soil and vegetation parameters that appear to be important:

- 1) The effective rooting depth appears to be related to vegetation type.
- 2) The effective rooting depth appears to be directly related to total percent cover in the juniper type.

- 3) The percentage of sand appears to be directly related to total percent cover in the juniper type
- 4) The percentage of very fine sand appears to be inversely related to total percent cover in the juniper type.
- 5) The percentage of silt appears to be inversely related to total percent cover in the juniper type.
- 6) The percentage of silt appears to be related to vegetation type.
- 7) The pH of a 1:5 dilution appears to be related to vegetation type.
- 8) The pH of a saturated soil paste appears to be inversely related to total percent cover in the juniper type.
- 9) The percentage of calcium carbonate appears to be inversely related to total percent cover in the juniper type.
- 10) The percent soil moisture in the profile at 15 bars appears to be related to vegetation type.

Strong definitive expression has been purposefully not developed for apparent trends or relations of soils and vegetation from the 16 study sites of this report. Substantive information can be derived from the data of course, but because of limited sample size such expression of relations or cause and effect responses, in a quantitative sense at least, cannot be finalized until the completion of additional analyses from the combined data sets of the three reports in this series.

LITERATURE CITED

- Black, C. A. (ed.). 1965. Methods of soil analysis. Part 1. Physical and mineral properties, including statistics of measurement and sampling. Agronomy 9. Amer. Soc. Agron. Madison, Wisconsin. 770 pp.
- Bouyoucos, G. J. 1936. Directions for making mechanical analysis of soils by the hydrometer method. Soil Sci. 42:225-228.
- Fisser, H. G., J. T. Nichols, and R. W. Hamner. 1963. Halogeton Research. 1962 Results. Univ. of Wyo. Coop. Res. Report to the BLM. Sections I-III. Wyo. Agr. Exp. Sta. Mimeo. pp. 1-38.
- Fisser, H. G., J. G. Nichols, R. W. Hamner, and J. R. Wight. 1964. Halogeton Research. 1963 Results. Univ. of Wyo. Coop. Res. Report to the BLM. Sections I-VIII. Wyo. Agr. Exp. Sta. Mimeo. pp. 1-61.
- Fisser, H. G., J. R. Wight, J. R. Flesland, L. D. Robinson. 1965. Halogeton Research. 1964 Results. Univ. of Wyo. Coop. Res. Report to the BLM. Sections I-VI. Wyo. Agr. Exp. Sta. Mimeo. pp. 1-82.
- Fisser, H. G., L. D. Robinson, D. R. Kirkham, R. Steger, and G. Noller. 1966. Halogeton Research. 1965 Results. Univ. of Wyo. Coop. Res. Report to the BLM. Sections I-V. Wyo. Agr. Exp. Sta. Mimeo. 134 pp.
- Fisser, H. G. 1967. Exclosure study with transects of permanent plots. Univ. of Wyo. Coop. Res. Rep. to the BLM. Wyo. Agr. Exp. Sta. Scientific Report No. 69. 94 pp.
- Fisser, H. G., G. Noller, R. E. Steger, D. R. Kirkham, and T. King. 1967. Arid Land Ecology Research. 1966 Results. Univ. of Wyo. Coop. Res. Rep. to the BLM. Sections I-VI. Wyo. Agr. Exp. Sta. Scientific Report No. 41. 137 pp.
- Fisser, H. G. 1968. Exclosure studies with transects of permanent plots. 1967 Results. Univ. of Wyo. Coop. Res. Rep. to the BLM. Wyo. Agr. Exp. Sta. Scientific Report No. 118. 52 pp.
- Fisser, H. G. 1968. Long term exclosure studies with 2' x 20' and 4' x 4' permanent plots. 1959-1964 Results. Univ. Agr. Exp. Sta. Scientific Report No. 131. 78 pp.
- Fisser, H. G., and G. L. Whysong. 1969. Arid Land Ecology Research 1968 Results. Univ. of Wyo. Coop. Res. Rep. to the BLM. Sections I-IV. Wyo. Agr. Exp. Sta. Scientific Report No. 178. 114 pp.

- Fisser, H. G. and G. L. Whysong. 1970 Arid Land Ecology Research. 1969 Results. Univ. of Wyo. Coop. Res. Rep. to the BLM. Sections I-IV. Wyo. Agr. Exp. Sta. Scientific Report No. 240. 128 pp.
- Fisser, H. G. 1970. Exclosure studies with transects of permanent plots. 1969 Results. Univ. of Wyo. Coop. Res. Rep. to the BLM. Wyo. Agr. Exp. Sta. Scientific Report No. 275. 84 pp.
- Fisser, H. G., and R. E. Ries. 1971. Arid Land Ecology Research. 1970 Results. Univ. of Wyo. Coop. Res. Rep. to the BLM. Sections I-IV. Wyo. Agr. Exp. Sta. Scientific Report No. 350. 133 pp.
- Fisser, H. G., and R. E. Ries. 1972. Arid Land Ecology Research. 1971 Results. University of Wyoming Coop. Res. Rep. to the BLM. Sections I and II. Wyo. Agr. Exp. Sta. Scientific Report No. 428. 130 pp.
- Fisser, H. G., and R. E. Ries. 1973. Arid Land Ecology Research. 1972 Results. University of Wyoming Coop. Res. Rep. to the BLM. Section I and II. Wyo. Agr. Exp. Sta. Scientific Report No. 521. 128 pp.
- Fisser, H. G., and R. E. Ries. 1974. Summary of data, 1962-1970. Arid Land Ecology Research. Univ. of Wyo. Coop. Res. Rep. to the BLM. Wyo. Agr. Exp. Sta. Scientific Report No. 556. 132 pp.
- Fisser, H. G., and L. H. Kleinman. 1974. Phenology and Production on Semi-Arid Shrub Types. 1973 Results. University of Wyoming Research Report to the BLM. Sections I, II and III. Wyo. Agr. Exp. Sta. Scientific Report No. 607. 256 pp.
- Fisser, H. G., and L. H. Kleinman. 1975. Phenology and Production on Semi-Arid Shrub Types. 1974 Results. University of Wyoming Research Report to the BLM. Sections I, II and III. Wyo. Agr. Exp. Sta. Scientific Report No. 729. 399 pp.
- Fisser, H. G., and L. H. Kleinman. 1976. Phenology and Production Studies on Semi-Arid Shrub Types. 1975 Results. University of Wyoming Coop. Research Report to the BLM. Sections I, II and III. Wyo. Agr. Exp. Sta. Scientific Report No. 831. 410 pp.
- Fisser, H. G., L. W. Young, J. E. Orpet, and N. E. Hargis. 1978. Phenology and Production Studies on Semi-Arid Shrub Types. 1976 Results. University of Wyoming Coop. Res. Report to the BLM. Sections I-IV. Wyo. Agr. Exp. Sta. Scientific Report No. 930. 438 pp.

- Fisser, H. G., D. C. Trueblood, and D. D. Samuelson, 1979. Soil-vegetation relationships on rangeland exclosures in the Grass Creek Planning Unit of north central Wyoming. Univ. of Wyo. Coop. Res. Report to the BLM. Wyo. Agr. Exp. Sta. Scientific Report No. 969. 279 pp.
- Fisser, H. G., and D. C. Trueblood. 1980a. Soil-vegetation relationships on rangeland exclosures in the Salt Wells Planning Unit of southwestern Wyoming. Univ. of Wyo. Coop. Res. Report to the BLM. Wyo. Agr. Exp. Sta. Scientific Report No. 1041. 68 pp.
- Fisser, H. G. and D. C. Trueblood. 1980b. Soil-vegetation relationships on rangeland exclosures in the Overland Planning Unit of southcentral Wyoming. Univ. of Wyo. Coop. Res. Report to the BLM. Wyo. Agr. Exp. Sta. Scientific Report No. 1042. 75 pp.
- Gdara, Abdalla O. 1977. Interpretation of long-term vegetation data from permanent quadrats on semi-arid shrublands of western Wyoming. M.S. Thesis. University of Wyoming 114 pp.
- Kleinman, Larry H. 1976. Phenodynamics and ecology of sagebrush-grass rangelands. Ph.D. Thesis. University of Wyoming. 143 pp.
- Orpet, James. 1978. Long-term herbage production response following the chemical control of big sagbrush. M.S. Thesis. University of Wyoming.
- Ries, Ronald E. 1973. Quantitative Evaluation of Herbage Production and Site Factors on Ecologically Diverse Sagebrush-grass Locations in Wyoming. Ph.D. Thesis. University of Wyoming. 101 pp.
- Soil Conservation Service. 1972. Soil survey laboratory methods and procedures for collecting soil samples. Soil Survey Investigation Report No. 1, U.S.D.A.
- Soil Survey Staff. 1975. Soil Taxonomy. A basic system of soil classification for making and interpreting soil surveys. U.S.D.A. Agriculture Handbook No. 326. 754 pp.
- Stephens, J.R. 1979. Personal communication. Soil Scientist, Soil Conservation Service, Buffalo, Wyoming.
- U.S. Salinity Laboratory. 1954. Diagnosis and improvement of saline and alkali soils. U.S.D.A. Handbook 60.
- Walkley, A. and I. A. Black. 1934. An examination of the Degtjoreff Method and proposed modification of the chromic and titration method. Soil. Sci. 37:29, 38.

APPENDIX A

SOIL PROFILE DESCRIPTIONS

Table of Contents

<u>Study Site</u>	<u>Page</u>
Oppenheimer	29
Poison Buttes #1.	30
Poison Buttes #2 (Livestock).	31
Powder Rim A.	32
Powder Rim B #1 (ARTR).	33
Powder Rim B #1 (ATGA).	34
Powder Rim B #2 (GRSP).	35
Powder Rim C.	36
Powder Rim D.	37
Red Wash #1 (ATGA).	38
Red Wash #1 (GRSP).	39
Red Wash #2 (Grass)	40
Red Wash #2 (GRSP).	41
Red Wash #3 (ARPE).	42
Red Wash #3 (ARTR).	43

SATANKA (Oppenheimer Exclosure)

Soil Family: Borollic Haplargid; fine-loamy, mixed

Location: Carbon County, Wyoming; SW $\frac{1}{4}$, Section 5, T13N, R92W.

Climate: Mean annual precipitation for 13 years of record is 9.60 inches. Mean annual air temperature is about 43°F, mean summer air temperature is about 64°F, and the frost-free season is about 100 days.

Vegetation: Big sagebrush, Needleandthread

Parent Material: Alluvium and residuum

Topography: 3 percent, north facing slope; elevation 6300 ft.

Physiography: Upland pediment

Drainage: Well drained

Groundwater: Deep

Erosion: Slight

Permeability: Moderate

Sampled by: H. Ravenholt, M. Suhr, C. Voigt, D. Trueblood, and D. Rodgers

Described by: H. Ravenholt, 6-25-79

(Colors are for dry soil unless otherwise stated).

A1 0 to 5 cm. (0-2"). Brown (10YR 5/3) fine sandy loam, brown (10YR 4/3) moist; weak very fine granular structure with a weak thin platy crust on surface; soft, friable, slightly plastic; mildly alkaline (pH 7.4); many roots; abrupt wavy boundary.

B2lt 5 to 10 cm. (2-4"). Brown (10YR 5/3) light sandy clay loam (?); moderate medium prismatic structure; slightly hard, friable, sticky, plastic; mildly alkaline (pH 7.4); many roots; clear wavy boundary.

B22t 10 to 25 cm. (4-10"). Brown (10YR 5/3) loam, brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; slightly hard, friable, sticky and plastic; slightly effervescent; strongly alkaline (pH 8.6); common roots; gradual wavy boundary.

B3ca 25 to 50 cm. (10-20"). Light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; weak medium prismatic structure with lime coatings; slightly hard, friable, sticky and plastic; strongly effervescent; strongly alkaline (pH 9.0); common roots; clear wavy boundary.

C1 50 to 94 cm. (20-37"). Pale olive (5Y 6/3) loam; olive (5Y 5/3) moist; massive; slightly hard, friable, sticky and plastic; common roots; strongly effervescent; moderately alkaline (pH 8.0); abrupt wavy boundary.

Cr 94 cm. (37"). Shale

FLEUTSCH (Poison Buttes Exclosure #1)

Soil Family: Borollic Haplargid; fine-loamy, mixed

Location: Carbon County, Wyoming; SE $\frac{1}{4}$, Section 25, T13N, R92W.

Climate: Mean annual precipitation for 13 years of record is 10.66 inches. Mean annual air temperature is about 42°F, mean summer air temperature is about 64°F, and the frost-free season is about 100 days.

Vegetation: Big sagebrush, Western wheatgrass, Prairie junegrass, Needleandthread.

Parent Material: Alluvium

Topography: Gently sloping, 4 percent north facing slope; elevation 6800 ft.

Physiography: Alluvial slope

Drainage: Well drained

Groundwater: Deep

Erosion: Slight

Permeability: Moderate

Sampled by: H. Ravenholt, M. Suhr, C. Voigt, D. Trueblood, and D. Rodgers.

Described by: H. Ravenholt, 6-26-79.

(Colors are for dry soil unless otherwise stated)

A1 0 to 8 cm. (0-3"). Grayish brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; weak medium platy structure parting to moderate medium granular; soft, friable, non-sticky, slightly plastic, mildly alkaline (pH 7.4); many very fine and fine roots; clear wavy boundary.

B21t 8 to 18 cm. (3-7"). Brown (7.5YR 5/4) loam, brown (7.5YR 4/4) moist; moderate medium prismatic structure, slightly hard, friable, slightly sticky, plastic; mildly alkaline (pH 7.6); many very fine and fine root; clear wavy boundary. Common thin clay films on ped faces.

B22t 18 to 38 cm. (7-15"). Brown (7.5YR 5/4) sandy clay loam, brown (7.5YR 4/4) moist; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; mildly alkaline (pH 7.8); common very fine to medium roots; clear wavy boundary.

B3 38 to 66 cm. (15-26"). Light brown (7.5YR 6/4) sandy loam, brown (7.5YR 4/4) moist; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; mildly alkaline (pH 7.8) common very fine to medium roots; clear wavy boundary.

Clca 66 to 81 cm. (26-32"). White (10YR 8/2) sandy loam, light gray (10YR 7/2) moist; massive; soft, very friable, slightly sticky, non-plastic; strongly effervescent; moderately alkaline (pH 8.2); few roots; clear wavy boundary.

C2 81 to 96 cm. (32-38"). Very pale brown (10YR 8/3) sandy loam, pale brown (10YR 6/3) moist; massive; soft, very friable, slightly sticky, non-plastic; slightly effervescent; moderately alkaline (pH 8.2) few roots; clear wavy boundary.

C3 96 to 150 cm. (38-60"). Very pale brown (10YR 8/3) loamy coarse sand; very pale brown (10YR 8/3) moist; single grain, loose.

GLENDIVE (Poison Buttes Exclosure #2-Livestock Exclusion Part)

Soil Family: Ustic Torrifluvent; coarse-loamy, mixed (calcareous), frigid.

Location: Carbon County, Wyoming; SE $\frac{1}{4}$, Section 36, T13N, R92W.

Climate: Mean annual precipitation for 13 years of record is 10.94 inches. Mean annual air temperature is about 42°F, mean summer air temperature is about 64°F, and the frost-free season is about 100 days.

Vegetation: Utah juniper

Parent Material: Alluvium

Topography: 5 percent southwest slope; elevation 6600 ft.

Physiography: Alluvial fan

Drainage: Well drained

Groundwater: Deep

Erosion: Slight

Permeability: Moderately rapid

Sampled by: H. Ravenholt, M. Suhr, C. Voigt, D. Trueblood, and D. Rodgers.

Described by: H. Ravenholt, 6-26-79

(Colors are for dry soil unless otherwise stated)

A1 0 to 3 cm. (0-1"). Grayish brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) moist; weak medium granular; soft, very friable, slightly sticky, slightly plastic; strongly effervescent; moderately alkaline (pH 8.0); 5 percent gravel, abrupt wavy boundary.

B 3 to 13 cm. (1-5"). Brown (10YR 5/3) gravelly sandy loam, brown (10YR 4/3) moist; single grain; loose; strongly effervescent; moderately alkaline (pH 8.0); 20 percent gravel; clear wavy boundary.

C1 13 to 33 cm. (5-13"). Brown (10YR 5/3) sandy clay loam, brown (10YR 4/3) moist; massive; slightly hard friable, sticky, plastic; strongly effervescent, moderately alkaline (pH 8.0); clear irregular boundary.

C2 33 to 66 cm. (13-26"). Brown (10YR 5/3) stratified gravelly loamy sand, brown (10YR 4/3) moist; massive; slightly hard friable, sticky, plastic; strongly effervescent, moderately alkaline (pH 8.0); clear irregular boundary.

C3 66 to 150 cm. (26-60"). Brown (10YR 5/3) coarse sandy loam, brown (10YR 4/3) moist; massive; soft, very friable, slightly sticky, slightly plastic; strongly effervescent; moderately alkaline (pH 8.0); 12 percent gravel.

KAPPES (P) (Powder Rim Pasture A Exclosure)

Soil Family: Borollic Calciorthid; coarse-loamy, mixed

Location: Sweetwater County, Wyoming; SW $\frac{1}{4}$, Section 25, T13N, R95W.

Climate: Mean annual precipitation for 13 years of record is 9.15 inches. Mean annual air temperature is about 40°F, mean summer air temperature is about 62°F, and the frost-free season is about 100 days.

Vegetation: Big sagebrush, Western wheatgrass, Prairie junegrass, Needleandthread.

Parent Material: Residium from Laney shale, Green River formation.

Topography: 5 percent northeast slope, elevation 6900 ft.

Physiography: Upland pediment

Drainage: Well drained

Groundwater: Deep

Erosion: Slight

Permeability: Moderately rapid

Sampled by: H. Ravenholt, D. Larson, D. Trueblood, and D. Rodgers

Described by: H. Ravenholt, 6-27-79.

(Colors are for dry soil unless otherwise noted)

A11 0 to 8 cm. (0-3"). Grayish brown (10YR 5/2) fine sandy loam, dark brown (10YR 3/3) moist; moderate, very fine granular structure; soft, very friable, slightly sticky, slightly plastic; mildly alkaline (pH 7.8); many fine to medium roots; abrupt wavy boundary.

A12ca 8 to 23 cm. (3-9"). Brown (10YR 5/3) fine sandy loam, brown (10YR 4/3) moist; weak medium subangular blocky structure parting to weak fine granular; soft, very friable, slightly sticky, slightly plastic; strongly effervescent; moderately alkaline (pH 8.0); many fine and medium roots; clear wavy boundary.

C1ca 23 to 35 cm. (9-14"). Light olive brown (2.5Y 5/4) shaley loamy sand, weathered sandstone that works down to sandy loam, olive brown (2.5Y 4/4) moist; slightly sticky, non-plastic; strongly effervescent; moderately alkaline (pH 8.0); lime crusts on sandstone fragments; few fine roots; clear wavy boundary.

C2 35 to 86 cm. (14-34"). Light yellowish brown (2.5Y 6/4) moist shaley loamy sand as above; gradual wavy boundary.

C3r 86 (34"). Sandstone bedrock.

FORELLE (Powder Rim Pasture B Enclosure #1-ARTR Type)

Soil Family: Borollic Haplargid; fine-loamy, mixed

Location: Sweetwater County, Wyoming; SW $\frac{1}{4}$, Section 36, T13N, R95W.

Climate: Mean annual precipitation for 13 years of record is 8.50 inches. Frost-free season is about 100 days.

Vegetation: Big sagebrush, Western wheatgrass

Parent Material: Alluvium

Topography: 2 percent southfacing slope; Elevation 6500 ft.

Physiography: Alluvial fan

Drainage: Well drained

Groundwater: Deep

Permeability: Moderate

Sampled by: L. Malnor and D. Trueblood

Described by: L. Malnor, 8-3-79

(Colors are for dry soil unless otherwise noted)

A1 0 to 4 inches. Grayish brown (10YR 5/2) loam; very dark grayish brown (10YR 3/2) moist; moderate fine granular; soft, friable, slightly sticky, slightly plastic; slightly effervescent*; moderately alkaline (pH 8.0); abrupt smooth boundary.

B1 4 to 8 inches. Pale brown (10YR 6/3) clay loam; brown to dark brown (10YR 4/3) moist; weak medium prismatic, slightly hard, friable, sticky; plastic, strongly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

B21T 8 to 14 inches. Yellowish brown (10YR 5/4) clay loam; dark yellowish brown (10YR 4/4) moist; moderate medium prismatic separating to moderate medium subangular blocky, slightly hard, friable, sticky, plastic violently effervescent; moderately alkaline (pH 8.2) clear smooth boundary.

B22T 14-22 inches. Light yellowish brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) moist; moderate medium prismatic, hard, friable, sticky, plastic; violent effervescence, moderately alkaline (pH 8.4); gradual smooth boundary.

C1 22-34 inches. Light yellowish brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) moist; massive, slightly hard, friable, sticky, plastic, violent effervescence; strongly alkaline (pH 8.6); gradual smooth boundary.

C2 34-60 inches. Light yellowish brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) moist; massive, slightly hard, friable, sticky, plastic; violent effervescence, strongly alkaline (pH 8.8).

* This site received calcareous run-in from surrounding outcrops.

TISWORTH (Powder Rim Pasture B Exclosure #1-ATGA Type)

Soil Family: Borollic Natrargid; fine-loamy, mixed.

Location: Sweetwater County, Wyoming; SW $\frac{1}{4}$, Section 36, T13N, R95W.

Climate: Mean annual precipitation for 13 years of record is 8.50 inches. Frost-free season is about 100 days.

Vegetation: Gardner saltbush, Western wheatgrass

Parent Material: Alluvium

Topography: 2 percent south facing slope; elevation 6500 ft.

Physiography: Alluvial fan

Drainage: Well drained

Groundwater: Deep

Permeability: Moderate

Sampled by: L. Malnor and D. Trueblood

Described by: L. Malnor, 8-3-79

(Colors are for dry soil unless otherwise noted)

A1 0 to 4 inches. Pale brown (10YR 6/3) clay loam, brown to dark brown (10YR 4/3) moist; moderate fine crumb; soft, very friable, plastic, sticky; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

B1 4 to 9 inches. Pale brown (10YR 6/4) clay loam, dark yellowish brown (10YR 4/4) moist; weak medium prismatic separating to moderate medium subangular blocky; slightly hard, friable, plastic, sticky; violently effervescent; moderately alkaline (pH 8.4) clear, smooth boundary.

B2T 9 to 19 inches. Pale brown (10YR 6/4) clay loam, dark yellowish brown (10YR 4/4) moist; moderate medium prismatic; hard, friable, sticky, plastic; violently effervescent; strongly alkaline (pH 8.8); clear, smooth boundary.

B3 19 to 26 inches. Pale brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) moist; weak medium prismatic; slightly hard, friable, sticky, plastic; violently effervsecent; moderately alkaline (pH 8.4); clear, smooth boundary.

C 26 to 60 inches. Very pale brown (10YR 7/4) clay loam, yellowish brown (10YR 5/4) moist; massive, slightly hard, friable, sticky, plastic; violently effervescent; moderately alkaline (pH 8.4).

* (Powder Rim Pasture B Exclosure #2)

Soil Family: Borollic Calciorthid; fine-loamy, carbonitic

Location: Sweetwater County, Wyoming; NW $\frac{1}{4}$, Section 10, T12N, R95W.

Climate: Mean annual precipitation for 13 years of record is 10.25 inches. Frost-free season is about 100 days.

Vegetation: Utah juniper

Parent Material: Alluvium

Topography: 8 percent south facing slope; elevation 6800 ft.

Drainage: Well drained

Groundwater: Deep

Permeability: Moderate

Sampled by: L. Malnor and D. Trueblood

Described by: L. Malnor, 8-3-79

(Colors are for dry soil unless otherwise noted)

A1 0 to 5 inches. Brown (10YR 5/3) gravelly loam, dark brown (10YR 3/3) moist; weak medium granular, soft, very friable, slightly sticky, slightly plastic; violently effervescent; moderately alkaline (pH. 8.2); clear, smooth boundary.

A3 5 to 10 inches. Very pale brown (10YR 7/3) gravelly loam, pale brown (10YR 6/3) moist; moderate medium subangular blocky, slightly hard, friable, slightly sticky, slightly plastic; violently effervescent; strongly alkaline (pH 8.6); gradual wavy boundary.

Clca 10-19 inches. Very pale brown (10YR 8/4) gravelly loam, very pale brown (10YR 7/4) moist; massive, slightly hard, friable, slightly sticky, slightly plastic; violently effervescent; strongly alkaline (pH 8.6) gradual wavy boundary.

C2 19 to 60 inches. Very pale brown (10YR 8/4) gravelly coarse sandy loam, very pale brown (10YR 7/4) moist; massive, soft, very friable, non-sticky, slightly plastic; violently effervescent; strongly alkaline (pH 8.8)

* --- No correlation to an existing series.

PEPAL (P) (Powder Rim Pasture C Exclosure)

Soil Family: Typic Calciorthid; coarse-loamy, mixed, frigid

Location: Carbon County, Wyoming; SW $\frac{1}{4}$, Section 28, T13N, R93W.

Climate: Mean annual precipitation for 13 years of record is 8.29 inches. Mean annual air temperature is about 44°F, mean summer air temperature is about 65°F, and the frost-free season is about 100 days.

Vegetation: Big sagebrush, Needleandthread, Indian ricegrass.

Parent Material: Alluvium

Topography: 1 percent southwest slope; elevation 6300 ft.

Physiography: Alluvial fan

Drainage: Well drained

Groundwater: Deep

Erosion: None

Permeability: Moderately rapid

Sampled by: H. Ravenholt, M. Suhr, C. Voigt, D. Trueblood, and D. Rodgers

Described by: H. Ravenholt, 6-26-79.

(Colors are for dry soil unless otherwise noted)

A1 0 to 5 cm. (0-2"). Pale brown (10YR 6/3) sandy loam, brown (10YR 4/3) moist; moderate fine granular; soft, very friable, slightly sticky, slightly plastic; mildly alkaline (pH 7.6); abrupt wavy boundary.

B2 5 to 20 cm. (2-8"). (7.5YR 5/4) sandy loam, brown (7.5YR 4/4) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky, slightly plastic; mildly alkaline (pH 7.6); clear wavy boundary.

B3ca 20 to 28 cm. (8-11"). Light brown (7.5YR 6/4) sandy loam, brown (7.5YR 4/4) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky, slightly plastic; strongly effervescent; moderately alkaline (pH 8.0); clear wavy boundary.

C1ca 28 to 48 cm. (11-19"). Very pale brown (10YR 8/3) sandy loam, brown (10YR 5/3) moist; massive; soft, very friable, slightly sticky, non-plastic; violently effervescent; moderately alkaline (pH 8.0); clear wavy boundary.

C2ca 48 to 79 cm. (19-31"). Very pale brown (10YR 7/4) sandy loam, yellowish brown (10YR 5/4) moist; massive; soft, very friable, slightly sticky, non-plastic; strongly effervescent; strongly alkaline (pH 8.8); clear wavy boundary.

C3ca 79 to 102 cm. (31-41"). White (2.5Y 8/2) sandy loam, light brownish gray (2.5Y 6/2) moist; massive; soft, very friable, slightly sticky, non-plastic; strongly effervescent; strongly alkaline (pH 9.0); clear wavy boundary.

C4 102 to 150 cm. (41-60"). White (2.5Y 8.2) loamy sand, light gray (2.5Y 7/2) moist; single grain; loose; slightly effervescent; strongly alkaline (pH 8.8).

RAVALLI (Powder Rim Pasture D Exclosure)

Soil Family: Borollic Natrargid; fine-loamy, mixed

Location: Sweetwater County, Wyoming; SW $\frac{1}{4}$, Section 26, T13N, R94W.

Climate: Mean annual precipitation for 13 years of record is 7.54 inches. Frost-free season is about 100 days.

Vegetation: Big sagebrush, Needleandthread

Parent Material: Alluvium

Topography: 5 percent north facing slope; elevation 6300'

Physiography: Alluvial fan

Drainage: Well drained

Groundwater: Deep

Permeability: Moderately rapid

Sampled by: L. Malnor and D. Trueblood

Described by: L. Malnor, 8-2-79

(Colors are for dry soil unless otherwise noted)

A1 0 to 8 in. Brown (10YR 5/3) coarse sandy clay loam, brown to dark brown (10YR 4/3) moist; moderate coarse granular; slightly hard; very friable; slightly sticky; plastic; strong effervescence; moderately alkaline (pH 8.4); abrupt smooth boundary.

B1 8 to 15 in. Brown (10YR 5/3) coarse sandy loam; brown to dark brown (10 YR 4/3) moist; weak medium prismatic separating to moderate coarse subangular blocky; slightly hard; very friable; non-sticky; slightly plastic; strong effervescence; moderately alkaline (pH 8.4); clear smooth boundary.

B2t 15 to 26 in. Brown (10YR 5/3) coarse sandy clay loam; brown to dark brown (10YR 4/3) moist; moderate medium prismatic; hard; friable; sticky; plastic; violent effervescence; very strongly alkaline (pH 9.4); clear smooth boundary.

B3 26 to 33 in. Brown (10YR 5/3) coarse sandy clay loam; brown to dark brown (10YR 4/3) moist; moderate medium prismatic; slightly hard; friable; slightly sticky; slightly plastic; violently effervescent; very strongly alkaline (pH 9.6); clear smooth boundary

C 33 to 60 in. Light brown (7.5YR 6/4) coarse sandy loam; brown (7.5YR 6/4) moist; massive; slightly hard; very friable; non-sticky; slightly plastic; violently effervescent; strongly alkaline (pH 8.8).

DEBONE (Red Wash Exclosure #1-ATGA Type)

Soil Family: Typic Natrargid; fine, montmorillonitic, frigid

Location: Carbon County, Wyoming; SW $\frac{1}{4}$, SE $\frac{1}{4}$, Section 22, T16N, R93W.

Climate: Mean annual precipitation for 18 years of record is 7.91 inches.

Vegetation: Gardner saltbush, Spiny horsebrush

Parent Material: Alluvium

Topography: 0 to 1 percent slope; elevation 5625 ft.

Physiography: Playa-like basin

Drainage: Moderately well drained

Groundwater: Deep

Erosion: None

Permeability: Very slow

Sampled by: H. Ravenholt, D. Larson, D. Trueblood, and D. Rodgers

Described by: H. Ravenholt, 6-27-79.

(Colors are for dry soil unless otherwise noted)

A1 0 to 4 cm. (0-1.5"). Light yellowish brown (10YR 6/4) silty clay loam, dark yellowish brown (10YR 4/4) moist; moderate very fine granular structure; soft, friable, very sticky, plastic, strongly effervescent; moderately alkaline (pH 8.2); few medium and coarse roots; abrupt wavy boundary. 5 to 15 mm cracks in surface.

B2t 4 to 18 cm. (1.5-7"). Pale brown (10YR 6/3) silty clay, brown (10YR 4/3) moist; moderate coarse columnar structure; very hard, firm, very sticky, very plastic; strongly effervescent, strongly alkaline (pH 9.0); few fine and medium roots; clear wavy boundary.

B3 18 to 50 cm. (7-20"). Pale brown (10YR 6/3) silty clay, brown (10YR 4/3) moist; weak very fine and fine subangular blocky structure; hard, firm, very sticky, very plastic; strongly effervescent; moderately alkaline (pH 8.0); few fine roots; clear wavy boundary.

C1 50 to 89 cm. (20-35"). Pale brown (10YR 6/3) silty clay; brown (10YR 4/3) moist; massive; hard, firm, very sticky, very plastic; strongly effervescent; moderately alkaline (pH 8.0); few fine roots; few mycelium or gyp crystals; clear wavy boundary.

C2 89+ cm. (35"+). Pale brown (10YR 6/3) silty clay; brown (10YR 4/3) moist; massive; hard, firm, very sticky, very plastic; strongly effervescent; moderately alkaline (pH 8.4).

KANDALY (P) (Red Wash Exclosure #1-GRSP Type)

Soil Family: Typic Torripsamment; mixed, frigid

Location: Carbon County, Wyoming: SW $\frac{1}{4}$, SE $\frac{1}{4}$, Section 22, T16N, R93W.

Climate: Mean annual precipitation for 18 years of record is 7.91 inches.

Vegetation: Spiny hopsage, Big sagebrush, Pricklypear cactus

Parent Material: Eolian sand

Topography: Short, choppy slopes; elevation 5625 ft.

Physiography: Dunes in a basin

Drainage: Somewhat excessive

Groundwater: Deep

Erosion: Moderate wind

Permeability: Rapid

Sampled by: H. Ravenholt, D. Larson, D. Trueblood, and D. Rodgers

Described by: H. Ravenholt, 6-27-79.

(Colors are for dry soil unless otherwise noted)

A1 0 to 38 cm. (0-15"). Pale brown (10YR 6/3) loamy fine sand; dark yellowish brown (10YR 4/4) moist; single grain; soft, very friable, very slightly sticky, non-plastic; strongly effervescent; mildly alkaline (pH 7.8); common fine and medium roots; clear wavy boundary.

C1 38 to 140 cm. (15-45"). Pale brown (10YR 6/3) loamy fine sand; dark yellowish brown (10YR 4/4) moist; single grain; soft, very friable; non-sticky, non-plastic; strongly effervescent; slightly alkaline (pH 7.8); common fine and medium roots; clear wavy boundary.

11C2 140+ cm. (45"+). Pale brown (10YR 6/3) silty clay; very sticky, very plastic; strongly effervescent; mildly alkaline (pH 7.8); few very fine roots.

* (Red Wash Exclosure #2 - Grass Type)

Soil Family: Typic Camborthid; fine-loamy, mixed (calcareous), frigid

Location: Sweetwater County, Wyoming; SE $\frac{1}{4}$, SW $\frac{1}{4}$, Section 2, T17N, R95W.

Climate: Mean annual precipitation for 18 years of record is 7.02 inches.

Vegetation: Big sagebrush, Indian ricegrass, bluebunch wheatgrass, Needleandthread

Topography: 0 to 1 percent slope; elevation 6375'

Groundwater: Deep

Sampled by: L. Malnor and D. Trueblood

Described by: L. Malnor, 8-2-79

(Colors are for dry soil unless otherwise noted)

A1 0 to 3 in. Light brownish gray (10YR 6/2) loamy sand, dark grayish brown (10YR 4/2) moist; single grain, loose; slightly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

A12 3 to 7 in. Pale brown (10YR 6/3) sandy clay loam, brown to dark brown (10YR 4/3) moist; moderate medium granular; slightly hard, friable; sticky, slightly plastic; strong effervescence; moderately alkaline (pH 8.2); clear smooth boundary.

B2 7-17 in. Light yellowish brown (10YR 6/4) clay loam, dark yellowish brown (10YR 4/4) moist; moderate coarse prismatic; slightly hard, friable, sticky, plastic; violent effervescence; moderately alkaline (pH 8.2); clear wavy boundary.

C1 17 to 24 in. Light yellowish brown (10YR 6/4) gravelly sandy clay loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, sticky, plastic; violent effervescence; moderately alkaline (pH 8.4); clear wavy boundary.

C2 24 to 38 in. Light yellowish brown (10YR 6/4) sandy clay loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, sticky, plastic; violent effervescence; moderately alkaline (pH 8.4).

R. 38 in. Soft calcareous sandstone.

*--No correlation to an existing series.

KANDALY (Red Wash Exclosure #2 - GRSP Type)

Soil Family: Typic Torripsamment, mixed (calcareous), frigid

Location: Sweetwater County, Wyoming; SE $\frac{1}{4}$, SW $\frac{1}{4}$, Section 2, T17N, R95W.

Climate: Mean annual precipitation for 18 years of record is 7.02 inches.

Vegetation: Spiny hopsage

Parent Material: Eolian sand

Topography: Short, choppy slopes; elevation 6375'

Physiography: Dunes

Groundwater: Deep

Sampled by: L. Malnor and D. Trueblood

Described by: L. Malnor, 8-2-79

(Colors are for dry soil unless otherwise noted)

A2 0 to 5 in. Pale brown (10YR 6/3) loamy sand, brown (10YR 4/3) moist; single grain, loose; non-effervescent; mildly alkaline (pH 7.8); gradual wavy boundary.

C1 5 to 28 in. Brown (10YR 5/3) loamy sand, brown to dark brown (10YR 4/3) moist; single grain, loose; non-effervescent; moderately alkaline (pH 8.0); gradual wavy boundary.

C2ca 28 to 42 in. Brown (10YR 5/3) loamy sand, brown to dark brown (10YR 5/3) moist; single grain, loose; slightly effervescent; moderately alkaline (pH 8.2); abrupt wavy boundary.

11C3ca 42 to 60 in. Very pale brown (10YR 7/3) clay loam, pale brown (10YR 6/3) moist; massive; slightly hard, friable; sticky and plastic; violently effervescent; strongly alkaline (8.6).

SANDBRANCH (P) (Red Wash Exclosure #3-ARPE Type)

Soil Family: Typic Natrargid; fine-loamy, mixed, frigid

Location: Carbon County, Wyoming; NW $\frac{1}{4}$, NE $\frac{1}{4}$, Section 6, T17N, R92W.

Climate: Mean annual precipitation for 18 years of record is 7.92 inches.

Vegetation: Birdsfoot sagewort, Western wheatgrass

Parent Material: Alluvium and residuum

Topography: 3 percent northwest slope; elevation 6550 ft.

Physiography: Upland pediment

Drainage: Well drained

Groundwater: Deep

Erosion: Slight

Permeability: Moderately slow

Sampled by: H. Ravenholt, M. Suhr, D. Trueblood, and D. Rodgers

Described by: H. Ravenholt, 6-27-79.

(Colors are for dry soil unless otherwise noted)

A1 0 to 5 cm. (0-2"). Brown (10YR 5/3) light sandy clay loam, brown (10YR 4/3) moist; moderate fine granular with upper 2 cm. a vesicular crust; soft very friable, slightly sticky, slightly plastic; moderately alkaline (pH 8.2); common very fine to medium roots; abrupt wavy boundary.

B21t 5 to 15 cm. (2-6"). Brown (10YR 5/3) light sandy clay loam, brown (10YR 4/3) moist; weak coarse prismatic structure with common thin clay films on faces of peds; hard, friable, sticky, plastic; strongly alkaline (pH 8.6); common very fine to medium roots; clear wavy boundary.

B22t 15 to 38 cm. (6-15"). Light gray (2.5Y 7/2) sandy clay loam, olive (5Y 5/3) moist; weak coarse sub-angular blocky structure; very hard, friable, sticky, slightly plastic; very strongly alkaline (pH 9.2).

C1 38 to 140 cm. (15-55"). Light gray (5Y 7/2) light sandy clay loam, olive (5Y 5/3) moist; weak fine angular blocky structure; slightly sticky, non-plastic; small yellowish brown mottles; a few 1" pockets of lime; strongly alkaline (pH 9.0); very few very fine roots; clear wavy boundary.

C2r 140 cm. (55"+). Soft sandstone bedrock.

* (Red Wash Exclosure #3-ARTR Type)

Soil Family: Typic Camborthid; coarse-loamy, mixed, frigid

Location: Carbon County, Wyoming; NW $\frac{1}{4}$, NE $\frac{1}{4}$, Section 6, T17N, R92W.

Climate: Mean annual precipitation for 18 years of record is 7.92 inches.

Vegetation: Big sagebrush, Sandburg bluegrass

Parent Material: Residium from sandstone

Topography: Slightly concave; snowdrift site; elevation 6550 ft.

Physiography: Upland pediment

Drainage: Well drained

Groundwater: Deep

Erosion: None

Permeability: Moderately rapid

Sampled by: H. Ravenholt, M. Suhr, D. Trueblood, and D. Rodgers

Described by: H. Ravenholt, 6-27-79.

(Colors are for dry soil unless otherwise noted)

A1 0 to 5 cm. (0-2"). Grayish brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure parting to moderate fine granular; soft, very friable, slightly sticky, slightly plastic; neutral (pH 7.2); many fine and medium and few coarse roots; abrupt wavy boundary.

B21 5 to 40 cm. (2-16"). Brown (10YR 5/3) fine sandy loam, brown (10YR 4/3) moist; weak coarse prismatic structure; hard, very friable, slightly sticky, slightly plastic; neutral (pH 7.2); common fine and medium and few coarse roots; gradual wavy boundary.

B22 40 to 76 cm. (16-30"). Brown (10YR 5/3) loam, brown (10YR 4/3) moist; weak coarse prismatic structure parting to weak medium subangular blocky; hard, very friable, slightly sticky, plastic; neutral (pH 7.2); common fine and medium and few coarse roots; clear wavy boundary.

Clca 76 to 145 cm. (30-57"). Brown (10YR 5/3) sandy clay loam; massive; slightly hard, friable, slightly sticky, plastic; mildly alkaline (pH 7.8); thin lime streaks; common fine roots; clear wavy boundary.

C2 145 to 178 cm. (57-70"). Brown (10YR 5/3) sandy loam, brown (10YR 4/4) moist; massive; slightly hard, friable, slightly sticky, plastic; mildly alkaline (pH 7.8).

*--No correlation to an existing series.

APPENDIX B
SOIL CHEMICAL ANALYSES

Table of Contents

<u>Study Site</u>	<u>Page</u>
Oppenheimer	45
Poison Buttes #1.	46
Poison Buttes #2 (Game)	47
Poison Buttes #2 (Livestock).	48
Powder Rim A.	49
Powder Rim B #1 (ARTR).	50
Powder Rim B #1 (ATGA).	51
Powder Rim B #2	52
Powder Rim C.	53
Powder Rim D.	54
Red Wash #1 (ATGA).	55
Red Wash #1 (GRSP).	56
Red Wash #2 (Grass)	57
Red Wash #2 (GRSP).	58
Red Wash #3 (ARPE).	59
Red Wash #3 (ARTR).	60

LAB ANALYSIS FOR OPPENHEIMER EXCLOSURE

ROOTING DEPTH 10"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A1	0-2	0	60	30	10	27.2	1.42	7.5	8.1	.4
B21t	2-4	2.6	62	24	14	24.0	1.55	8.0	8.7	.3
B22t	4-10	2.8	54	24	22	19.4	1.41	8.2	8.9	.3
B3ca	10-20	17.3	39	29	32	16.8	1.19	8.5	9.5	.6
C1	20-37	1.0	22	44	34	11.8	1.56	8.2	8.9	5.4

Horizon	Organic Matter (%)	CaCo ₃ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A1	6.2	0	23.42	14.39	9.03	19.70	9.47	10.23
B21t	2.6	1.0	13.99	11.32	2.67	15.58	11.36	4.22
B22t	2.8	13.5	17.99	13.79	4.20	23.53	13.93	9.60
B3ca	2.0	27.5	26.11	13.39	12.72	35.19	22.41	12.78
C1	2.0	14.5	35.47	29.00	6.47	35.35	24.00	11.35

LAB ANALYSIS FOR POISON BUTTES EXCLOSURE #1

ROOTING DEPTH 60"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A1	0-3	1.3	48	38	14	17.8	1.14	6.5	7.3	.3
B21t	3-7	1.1	52	29	19	21.8	1.46	7.0	7.6	.3
B22t	7-15	1.2	50	25	25	18.2	1.65	6.7	7.8	.2
B3	15-26	9.1	70	13	17	14.8	1.83	7.6	8.4	.3
Clca	26-32	7.1	78	10	12	6.8	*	8.6	9.3	.2
C2	32-38	5.3	84	6	10	4.6	*	8.5	9.5	.3
C3	38-60	5.1	86	6	8	4.4	*	8.8	9.6	.3

Horizon	Organic Matter (%)	CaCo ₃ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A1	5.3	0	11.43	7.69	3.74	17.54	5.81	11.73
B21t	4.7	6.0	23.04	14.07	8.97	16.04	9.76	6.28
B22t	1.4	5.5	15.53	10.96	4.57	22.45	12.10	10.35
B3	1.4	6.0	10.88	8.23	2.65	13.21	9.21	4.00
Clca	.6	3.5	10.67	2.20	8.47	26.83	6.63	20.20
C2	.3	2.5	8.50	1.95	6.55	7.89	6.02	1.87
C3	.3	.5	7.45	1.91	5.54	5.63	3.73	1.90

* -- Sample Not Available

LAB ANALYSIS FOR POISON BUTTES EXCLOSURE #2 (Game Exclosure)

ROOTING DEPTH 36"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
*	0-1	2.1	68	14	18	20.0	1.21	7.7	8.6	.3
*	1-18	.7	72	18	10	20.8	1.71	7.9	8.9	.2
*	18-36	.8	78	15	7	17.8	1.67	7.8	9.1	.2

Horizon	Organic Matter (%)	CaCo ₃ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
*	4.2	4.5	19.26	14.40	4.86	19.83	14.56	5.27
*	1.0	10.0	18.59	17.19	1.40	26.32	15.44	10.88
*	.3	7.5	23.74	14.74	9.00	18.56	15.45	3.11

* -- Profile Description Not Available

LAB ANALYSIS FOR POISON BUTTES EXCLOSURE #2 (Livestock Exclosure)

ROOTING DEPTH 60"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A1	0-1	6.8	62	27	11	14.8	1.34	6.5	7.6	.4
B	1-5	21.6	68	16	16	15.4	1.49	8.0	8.7	.2
C1	5-13	19.6	86	6	8	8.0	1.80	8.0	9.1	.2
C2	13-26	13.9	84	6	10	14.2	1.65	7.9	8.7	.3
C3	26-60	14.6	84	4	12	10.2	1.85	8.2	9.0	.2

Horizon	Organic Matter (%)	CaCo ₃ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A1	8.2	6.0	9.97	9.34	0.63	42.67	12.74	29.93
B	2.8	5.5	6.29	3.23	3.06	12.50	6.31	6.19
C1	.7	5.5	4.09	3.66	0.43	5.98	5.05	.93
C2	2.0	2.5	11.66	9.64	2.02	15.48	11.97	3.51
C3	1.1	.5	9.74	7.53	2.21	6.60	3.42	3.18

LAB ANALYSIS FOR POWDER RIM PASTURE A EXCLOSURE

ROOTING DEPTH 34"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A11	0-3	1.8	66	24	10	19.6	1.30	7.5	8.0	.5
A12ca	3-9	2.8	68	24	8	20.0	1.47	7.8	8.8	.3
Clca	9-14	2.2	78	16	6	15.2	1.40	8.4	8.9	.2
C2	14-34	3.0	86	6	8	5.4	1.48	8.6	9.3	.3

Horizon	Organic Matter (%)	CaCo ₃ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A11	4.6	5.0	14.46	4.48	9.98	16.04	11.24	4.80
A12ca	4.1	7.0	14.06	10.04	4.02	21.09	11.20	9.89
Clca	3.6	13.5	21.80	15.45	6.35	25.62	17.17	8.45
C2	1.0	9.0	16.04	8.08	7.96	17.07	10.91	6.16

LAB ANALYSIS FOR POWDER RIM PASTURE B EXCLOSURE #1 (ARTR Type)

ROOTING DEPTH 8"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A1	0-4	1.7	44	40	16	19.4	1.14	7.6	8.2	.4
B1	4-8	1.7	40	38	22	15.2	1.31	8.3	8.8	.2
B21t	8-14	2.6	40	36	24	14.6	1.38	8.2	8.8	.3
B22t	14-22	3.6	48	26	26	16.6	1.53	8.1	8.9	.3
C	22-60	6.2	40	36	24	15.8	1.34	8.3	9.4	.5

Horizon	Organic Matter (%)	CaCo ₃ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A1	15.6	6.5	16.07	6.25	9.82	23.26	2.82	20.44
B1	3.3	10.0	14.78	14.02	0.76	21.24	7.78	13.46
B21t	2.2	17.5	20.72	10.02	10.66	22.48	13.49	8.99
B22t	1.5	16.5	14.44	13.19	1.25	20.44	9.78	10.66
C	1.5	20.0	23.74	11.79	11.95	31.00	13.01	17.99

LAB ANALYSIS FOR POWDER RIM PASTURE B EXCLOSURE #1 (ATGA Type)

ROOTING DEPTH 60"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A1	0-4	1.7	33	43	24	15.2	1.23	8.2	9.1	.6
B1	4-9	1.4	36	34	30	13.0	1.17	8.2	8.9	.3
B2t	9-19	3.9	42	33	25	15.4	1.34	8.2	9.0	.3
B3	19-26	3.8	46	31	23	15.2	1.29	7.9	8.7	.4
C	26-60	2.6	38	36	26	14.2	1.45	8.1	8.7	1.1

Horizon	Organic Matter (%)	CaCo ₃ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A1	2.6	16.5	16.67	12.88	3.79	23.68	9.24	14.44
B1	2.9	16.0	20.48	11.40	9.08	31.58	15.32	16.26
B2t	2.1	16.5	23.42	14.39	9.03	25.69	15.20	10.49
B3	2.1	16.5	21.21	6.31	14.90	22.86	10.64	12.22
C	1.5	16.5	21.31	14.44	6.87	28.42	14.15	14.27

LAB ANALYSIS FOR POWDER RIM PASTURE B EXCLOSURE #2

ROOTING DEPTH 5"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A1	0-5	40.5	57	35	8	22.4	1.66	7.9	8.6	.4
A3	5-10	37.8	54	28	18	13.8	1.21	8.1	8.7	.3
Clca	10-19	33.4	48	27	25	5.8	1.30	8.2	9.2	.2
C2	19-60	18.2	64	22	14	3.8	1.69	8.2	9.5	.3

Horizon	Organic Matter (%)	CaCo ₃ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A1	8.3	16.0	8.78	3.89	4.89	17.82	8.84	8.98
A3	2.8	47.0	15.34	9.68	5.66	20.39	10.43	9.96
Clca	1.4	54.5	8.56	5.05	3.51	20.28	9.85	10.43
C2	.7	40.5	7.12	5.80	1.32	12.14	3.42	8.72

* -- Sample Not Available.

LAB ANALYSIS FOR POWDER RIM PASTURE C EXCLOSURE

ROOTING DEPTH 60"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A1	0-2	1.9	70	20	10	14.8	1.50	7.4	8.2	.4
B2	2-8	4.6	74	12	14	12.4	1.65	7.7	8.8	.5
B3ca	8-11	4.1	80	8	12	13.0	1.71	8.3	9.0	.3
C1ca	11-19	3.4	78	11	11	10.2	1.72	8.4	9.3	.4
C2ca	19-31	2.6	86	3	11	8.8	1.64	8.9	9.9	.3
C3ca	31-41	1.6	88	4	8	3.6	*	9.6	10.3	1.6
C4	41-60	.7	66	31	3	4.6	*	8.4	8.7	.5

Horizon	Organic Matter (%)	CaCo ₃ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A1	2.3	0	4.88	3.59	1.29	8.78	4.44	4.34
B2	1.2	.5	7.62	5.65	1.97	10.95	7.95	3.00
B3ca	.9	1.5	8.11	6.20	1.91	9.63	7.46	2.17
C1ca	.7	13.5	14.46	5.82	8.64	6.06	2.03	4.03
C2ca	.6	10.0	8.42	3.40	5.02	6.21	2.41	3.80
C3ca	.4	0	*	*	*	9.88	6.41	3.47
C4	.2	6.1	*	*	*	8.21	6.06	2.15

* -- Sample Not Available.

LAB ANALYSIS FOR POWDER RIM PASTURE D EXCLOSURE

ROOTING DEPTH 60"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A1	0-8	.7	70	18	12	15.4	1.56	8.1	9.2	.3
B1	8-15	.5	74	14	12	16.0	1.57	8.5	9.3	.3
B2t	15-26	0	66	19	15	15.8	1.49	9.0	9.9	.6
B3	26-33	0	70	16	14	17.2	1.62	9.1	10.0	.6
C	33-60	3.3	68	18	14	15.2	*	8.3	9.4	3.1

Horizon	Organic Matter (%)	CaCo ₃ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A1	.9	1.5	6.12	4.15	1.97	9.62	4.95	4.67
B1	.6	6.5	7.94	4.20	3.74	7.37	3.29	4.08
B2t	.7	9.0	12.36	5.08	7.28	15.45	7.69	7.76
B3	.8	10.0	7.59	2.65	4.94	14.75	7.69	7.06
C3	.6	5.0	*	*	*	11.76	7.25	4.51

* -- Sample Not Available.

LAB ANALYSIS FOR RED WASH ENCLOSURE #1 (ATGA TYPE)

ROOTING DEPTH 60"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A1	0-1½	0	48	28	24	20.8	1.17	8.1	8.9	.4
B2t	1½-7	0	37	21	42	19.6	1.45	8.6	9.9	.7
B3	7-20	1.5	32	16	52	12.0	1.60	8.6	9.9	1.0
C1	20-35	1.5	20	28	52	5.6	1.67	8.1	8.6	6.6
C2	35-60	0	18	30	52	4.4	*	8.3	9.6	2.8

Horizon	Organic Matter (%)	CaCO ₃ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A1	2.2	9.0	19.73	5.14	14.59	21.30	8.20	13.10
B2t	1.1	4.5	22.42	13.16	9.27	30.00	17.05	12.95
B3	1.2	5.5	29.38	16.50	12.88	37.19	26.35	10.84
C1	1.4	5.5	30.52	17.18	13.34	32.68	21.57	11.11
C2	1.3	6.0	*	*	*	38.40	22.00	16.40

* -- Sample Not Available

LAB ANALYSIS FOR RED WASH ENCLOSURE #1 (GRSP Type)

ROOTING DEPTH 60"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A1	0-15	0	84	10	6	30.2	1.25	8.9	9.4	.4
C1	15-45	0	92	2	6	15.0	1.20	9.3	10.1	.5
IIC2	45-60	0	42	16	42	17.0	1.81	8.7	9.9	1.4

Horizon	Organic Matter (%)	CaCo ₃ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A1	.8	4.5	6.88	2.30	4.58	4.49	1.64	2.85
C1	.5	4.5	2.43	1.38	1.05	6.04	3.31	2.73
IIC2	1.4	4.5	29.00	13.39	15.61	39.20	22.14	17.06

LAB ANALYSIS FOR RED WASH EXCLOSURE #2 (Grass Type)

ROOTING DEPTH 17"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A1	0-3	0	84	12	4	18.6	1.26	8.2	8.8	.3
A12	3-7	0	72	8	20	15.8	1.30	8.1	8.8	.4
B2	7-17	0	48	29	23	21.4	1.31	8.2	8.8	.3
C1	17-24	0	58	27	15	17.0	1.53	8.5	9.1	.3
C2	24-38	0	57	31	12	29.8	1.33	8.5	9.4	.3

Horizon	Organic Matter (%)	CaCo ₃ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A1	4.2	2.0	7.69	4.50	3.19	7.46	6.80	.66
A12	2.0	9.0	8.64	6.97	1.67	16.00	9.04	6.96
B2	1.6	13.0	14.81	7.84	6.97	21.54	12.98	8.56
C1	1.6	23.5	16.67	10.50	6.17	23.89	11.90	11.99
C2	.9	17.5	22.63	11.32	11.31	20.29	9.26	11.03

LAB ANALYSIS FOR RED WASH EXCLOSURE #2 (GRSP Type)

ROOTING DEPTH 42"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A2	0-5	0	96	0	4	4.8	1.40	8.2	8.7	.3
C1	5-28	0	92	4	4	5.6	1.34	8.4	8.9	.2
C2ca	28-42	1.8	80	13	7	14.4	1.26	8.5	9.0	.3
IIC3ca	42-60	3.0	36	43	21	10.4	*	8.2	9.1	.2

Horizon	Organic Matter (%)	CaCo ₃ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A2	.5	3.0	3.61	2.51	1.10	5.15	8.94	.21
C1	.8	4.0	4.62	2.79	1.83	4.83	2.17	2.66
C2ca	1.5	6.0	7.87	2.21	5.66	9.36	5.71	3.65
IIC3ca	1.3	16.0	*	*	*	39.36	13.01	26.35

* -- Sample Not Available.

LAB ANALYSIS FOR RED WASH ENCLOSURE #3 (ARPE Type)

ROOTING DEPTH 2"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A1	0-2	1.6	70	17	13	15.2	1.85	8.1	9.2	.4
B21t	2-6	2.0	62	13	25	13.0	1.63	8.5	9.5	.4
B22t	6-15	7.5	60	18	22	17.6	1.99	8.9	10.1	.8
C1	15-55	27.2	60	18	22	23.6	1.64	8.8	10.2	1.7

Horizon	Organic Matter (%)	CaCo ₃ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A1	1.1	3.0	7.63	3.78	3.85	10.53	6.63	3.90
B21t	1.8	17.0	15.26	8.80	6.46	15.22	12.27	2.95
B22t	1.3	7.0	8.91	7.69	1.22	22.13	9.56	12.57
C1	.6	6.0	9.63	4.63	5.00	21.13	7.95	13.18

LAB ANALYSIS FOR RED WASH EXCLOSURE #3 (ARTR Type)

ROOTING DEPTH 70"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A1	0-2	0	58	30	12	13.0	1.38	7.8	8.3	.3
B21t	2-16	1.5	62	26	12	25.2	1.47	7.3	7.7	.2
B22	16-30	1.0	62	21	17	18.2	1.83	7.3	8.1	.2
Clca	30-57	0	68	10	22	13.8	1.81	8.1	9.2	.2
C2	57-70	0	76	9	15	12.4	*	8.4	9.3	.2

Horizon	Organic Matter (%)	CaCo ₃ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A1	2.9	1.0	9.49	6.25	3.24	12.73	7.82	4.91
B21t	1.7	.5	13.04	7.02	6.02	14.71	5.54	9.12
B22	1.3	.5	9.73	7.73	2.00	13.28	7.14	6.14
Clca	.8	12.0	11.18	6.45	4.73	14.69	6.57	8.12
C2	.5	5.0	*	*	*	10.29	7.69	2.60

* -- Sample Not Available.

APPENDIX C

PERCENT VEGETATIVE COVER

Table of Contents

<u>Study Site</u>	<u>Page</u>
Oppenheimer	62
Poison Buttes #1.	63
Poison Buttes #2 (Game)	64
Poison Buttes #2 (Livestock).	65
Powder Rim A.	66
Powder Rim B #1 (ARTR).	67
Powder Rim B #1 (ATGA).	68
Powder Rim B #2	69
Powder Rim C.	70
Powder Rim D.	71
Red Wash #1 (ATGA).	72
Red Wash #2 (Grass)	73
Red Wash #3 (ARPE).	74
Red Wash #3 (ARTR).	75

PERCENT VEGETATIVE COVER
FOR
OPPENHEIMER EXCLOSURE

YEARS

		1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS							7.11	9.16		10.00
PERENNIAL GRASS							2.32	2.07		2.61
ANNUAL GRASS							0	0		0
PERENNIAL FORBS							.88	.15		.28
ANNUAL FORBS							.12	.10		.04
TOTAL							10.43	11.48		12.93

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	MEAN
SHRUBS	2.29				12.40				11.00	8.66
PERENNIAL GRASS	2.02				4.27				3.46	2.79
ANNUAL GRASS	0				0				0	0
PERENNIAL FORBS	.74				1.28				.62	.66
ANNUAL FORBS	.03				.09				.05	.07
TOTAL	5.08				18.04				15.13	12.18

PERCENT VEGETATIVE COVER
FOR
POISON BUTTES EXCLOSURE #1

YEARS										
		1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS							.03	.34		1.41
PERENNIAL GRASS							2.89	5.57		6.39
ANNUAL GRASS							.02	.03		0
PERENNIAL FORBS							.31	.12		.12
ANNUAL FORBS							.13	.26		.18
TOTAL							3.38	6.32		8.10

YEARS (CONTINUED)										
	1971	1972	1973	1974	1975	1976	1977	1978	1979	MEAN
SHRUBS	1.76				6.38				10.85	3.46
PERENNIAL GRASS	6.41				7.38				5.60	5.71
ANNUAL GRASS	0				.01				0	.01
PERENNIAL FORBS	.18				.44				.36	.26
ANNUAL FORBS	.26				.09				.16	.18
TOTAL	8.61				14.30				16.97	9.61

PERCENT VEGETATIVE COVER
FOR
POISON BUTTES EXCLOSURE #2
GAME EXCLUSION PART

YEARS

		1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS								19.65		20.85
PERENNIAL GRASS								2.38		1.18
ANNUAL GRASS								0		0
PERENNIAL FORBS								.36		.30
ANNUAL FORBS								.02		.02
TOTAL								22.41		22.35

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	MEAN
SHRUBS	20.85				21.63				19.41	20.48
PERENNIAL GRASS	1.13				1.55				1.75	1.60
ANNUAL GRASS	.01				.01				0	T
PERENNIAL FORBS	.30				.89				.60	.49
ANNUAL FORBS	.04				.05				.04	.03
TOTAL	22.33				24.13				21.80	22.60

PERCENT VEGETATIVE COVER
FOR
POISON BUTTES ENCLOSURE #2
LIVESTOCK EXCLUSION PART

YEARS

		1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS								23.29		24.13
PERENNIAL GRASS								1.24		.86
ANNUAL GRASS								.01		0
PERENNIAL FORBS								.18		.12
ANNUAL FORBS								.07		.05
TOTAL								24.79		25.16

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	MEAN
SHRUBS	23.96				25.32				17.65	22.87
PERENNIAL GRASS	1.18				1.13				1.05	1.09
ANNUAL GRASS	0				.03				.01	.01
PERENNIAL FORBS	.10				.55				.58	.31
ANNUAL FORBS	.07				.12				.12	.09
TOTAL	25.31				27.15				19.41	24.36

PERCENT VEGETATIVE COVER
FOR
POWDER RIM PASTURE A ENCLOSURE

YEARS

		1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS							.28	.63		.88
PERENNIAL GRASS							1.94	2.26		3.39
ANNUAL GRASS							0	0		0
PERENNIAL FORBS							.40	.40		.42
ANNUAL FORBS							.02	.02		0
TOTAL							2.64	3.31		4.69

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	MEAN
SHRUBS	1.12				3.88				6.13	2.15
PERENNIAL GRASS	3.41				3.99				4.42	3.24
ANNUAL GRASS	0				0				0	0
PERENNIAL FORBS	.54				1.17				1.39	.72
ANNUAL FORBS	.02				.05				0	.02
TOTAL	5.09				9.09				11.94	6.13

PERCENT VEGETATIVE COVER
FOR
POWDER RIM PASTURE B EXCLOSURE #1
ARTR TYPE

YEARS

		1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS							16.34	20.86		16.70
PERENNIAL GRASS							1.05	1.34		.97
ANNUAL GRASS							0	0		0
PERENNIAL FORBS							.02	.07		.01
ANNUAL FORBS							.06	.03		.02
TOTAL							17.47	22.30		17.70

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	MEAN
SHRUBS	16.41								16.01	17.26
PERENNIAL GRASS	1.11								2.18	1.33
ANNUAL GRASS	0								0	0
PERENNIAL FORBS	.01								.09	.04
ANNUAL FORBS	.03								.15	.06
TOTAL	17.56								18.43	18.69

PERCENT VEGETATIVE COVER
FOR
POWDER RIM PASTURE B EXCLOSURE #1
ATGA TYPE

YEARS

		1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS							5.02	8.42		13.33
PERENNIAL GRASS							.45	.49		1.03
ANNUAL GRASS							0	0		0
PERENNIAL FORBS							.10	0		.02
ANNUAL FORBS							.06	.06		.02
TOTAL							5.63	8.97		14.40

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	MEAN
SHRUBS	13.65								3.70	8.82
PERENNIAL GRASS	1.09								1.79	.97
ANNUAL GRASS	0								0	0
PERENNIAL FORBS	.02								.90	.21
ANNUAL FORBS	.02								.05	.04
TOTAL	14.78								6.44	10.04

PERCENT VEGETATIVE COVER
FOR
POWDER RIM PASTURE B ENCLOSURE #2

YEARS

		1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS								19.26		19.64
PERENNIAL GRASS								.15		.10
ANNUAL GRASS								0		0
PERENNIAL FORBS								2.00		2.64
ANNUAL FORBS								0		0
TOTAL								21.41		22.38

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	MEAN
SHRUBS	19.78				17.97				19.18	19.17
PERENNIAL GRASS	.08				.23				.28	.17
ANNUAL GRASS	0				0				0	0
PERENNIAL FORBS	2.33				2.56				2.50	2.41
ANNUAL FORBS	0				.01				0	T
TOTAL	22.19				20.77				21.96	21.74

PERCENT VEGETATIVE COVER
FOR
POWDER RIM PASTURE C ENCLOSURE

YEARS

		1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS							9.36	9.10		9.89
PERENNIAL GRASS							.50	.54		.68
ANNUAL GRASS							0	0		0
PERENNIAL FORBS							1.06	.28		.27
ANNUAL FORBS							.09	.06		.02
TOTAL							11.01	9.98		10.86

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	MEAN
SHRUBS	10.41				14.66				15.03	11.41
PERENNIAL GRASS	.82				1.85				3.48	1.31
ANNUAL GRASS	0				0				0	0
PERENNIAL FORBS	.31				1.78				2.58	1.05
ANNUAL FORBS	.05				.07				.10	.07
TOTAL	11.59				18.36				21.19	13.83

PERCENT VEGETATIVE COVER
FOR
POWDER RIM PASTURE D EXCLOSURE

YEARS

		1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS							3.09	3.58		3.31
PERENNIAL GRASS							2.20	2.10		2.27
ANNUAL GRASS							.01	.01		.01
PERENNIAL FORBS							.01	.04		.04
ANNUAL FORBS							.12	.02		.03
TOTAL							5.43	5.75		5.66

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	MEAN
SHRUBS	3.44				4.99				1.48	3.32
PERENNIAL GRASS	2.21				3.23				3.10	2.52
ANNUAL GRASS	0				.01				0	.01
PERENNIAL FORBS	.02				.05				.12	.05
ANNUAL FORBS	.04				.06				.11	.06
TOTAL	5.71				8.34				4.81	5.95

PERCENT VEGETATIVE COVER
FOR
RED WASH ENCLOSURE #1
ATGA TYPE

YEARS

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS	13.5			7.8				18.8		
PERENNIAL GRASS	.3			0				1.4		
ANNUAL GRASS	0			0				0		
PERENNIAL FORBS	0			0				0		
ANNUAL FORBS	.2			.4				.1		
TOTAL	14.0			8.2				20.3		

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	MEAN
SHRUBS		17.2				17.0				14.9
PERENNIAL GRASS		2.0				3.7				1.5
ANNUAL GRASS		0				0				0
PERENNIAL FORBS		.7				0				.1
ANNUAL FORBS		0				.1				.2
TOTAL		19.9				20.8				16.6

PERCENT VEGETATIVE COVER
FOR
RED WASH ENCLOSURE #2
GRASS TYPE

YEARS

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS	7.6			5.1				9.0		
PERENNIAL GRASS	39.3			7.9				13.2		
ANNUAL GRASS	0			0				0		
PERENNIAL FORBS	2.1			2.3				4.7		
ANNUAL FORBS	0			0				0		
TOTAL	49.0			15.3				26.9		

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	MEAN
SHRUBS		5.4				7.1				6.8
PERENNIAL GRASS		11.4				11.2				16.6
ANNUAL GRASS		0				0				0
PERENNIAL FORBS		4.9				1.7				3.1
ANNUAL FORBS		.2				0				T
TOTAL		21.9				20.0				26.6

PERCENT VEGETATIVE COVER
FOR
RED WASH EXCLOSURE #3
ARPE TYPE

YEARS

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS	12.3			8.4				9.1		
PERENNIAL GRASS	17.8			3.9				3.0		
ANNUAL GRASS	0			0				0		
PERENNIAL FORBS	1.5			1.3				1.7		
ANNUAL FORBS	0			0				0		
TOTAL	31.6			13.6				13.8		

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	MEAN
SHRUBS		4.8				9.4				8.8
PERENNIAL GRASS		5.4				5.5				7.1
ANNUAL GRASS		0				0				0
PERENNIAL FORBS		3.6				4.9				2.6
ANNUAL FORBS		0				0				0
TOTAL		13.8				19.8				18.5

PERCENT VEGETATIVE COVER
FOR
RED WASH ENCLOSURE #3
ARTR TYPE

YEARS

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS	56.6			33.3				47.6		
PERENNIAL GRASS	36.0			11.0				18.0		
ANNUAL GRASS	0			0				0		
PERENNIAL FORBS	0			.5				1.5		
ANNUAL FORBS	0			1.5				0		
TOTAL	92.6			46.3				67.1		

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	MEAN
SHRUBS		44.8				46.5				45.8
PERENNIAL GRASS		14.5				12.0				18.3
ANNUAL GRASS		0				0				0
PERENNIAL FORBS		1.5				2.0				1.1
ANNUAL FORBS		0				0				.3
TOTAL		60.8				60.5				65.5

BLM Library
Denver Federal Center
Bldg. 50, OC-521
P.O. Box 25047
Denver, CO 80225

BUREAU OF LAND MANAGEMENT

Library

Denver Service Center

BLM Library
Denver Federal Center
Bldg. 50, OC-521
P.O. Box 25047
Denver, CO 80225

